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Effectiveness of Buerger Allen's Exercise on Foot Perfusion Among Type 2 Diabetes Mellitus Patients

Ms. Jyoti Srivastava1[1*], Mrs. Rashmi P. John2[2], Dr. D. Himanshu Reddy3[3]
[1] M.sc Nursing 2nd year, King George's Medical University, Lucknow, [2] Assistant Professor, KGMU College of Nursing, King George's Medical University, Lucknow, [3] Additional Professor, Department of Internal Medicine, King George's Medical University, Lucknow
*jyotirn1824@gmail.com

ABSTRACT
Diabetic foot is a painful late complication of diabetes mellitus which occurs due to reduced foot perfusion (peripheral vascular disease), which results in maceration and amputation of foot in many cases. Buerger Allen's Exercise helps to increase foot perfusion and strengthen collateral circulation of foot. This study was aimed to determine the effectiveness of Buerger Allen's Exercise on foot perfusion among Type 2 Diabetes Mellitus patients in experimental group admitted in medicine ward, K.G.M.U, Lucknow. In this study quasi experimental Non- equivalent control group pre-post test design was applied. Convenience sampling technique was used to assign the 66 type 2 diabetes mellitus patients. The result revealed that pre test mean score and standard deviation of experimental group is 0.79 and 0.18 respectively and post test mean score and standard deviation is 0.93 and 0.14 respectively. Paired 't' test was (2.2158) greater than table value 2.037 of experimental group prove that this is statistically significant at $p < 0.05$. The application of Buerger Allen's exercise led to significant increases in the foot perfusion in Type 2 Diabetes Mellitus patients.
Keywords: Buerger Allen's Exercise, Type 2 Diabetes Mellitus patients, Foot perfusion

Introduction

Diabetes is one of the chronic metabolic disorders which materialize either when the pancreas is not able to produce sufficient insulin as required by the body or when the body is unable to use the produced insulin effectively. Diabetes Type 2 is the most common among various types of diabetes.[1] as per, the International Diabetes Federation, Type 2 Diabetes Mellitus accounts for 90% of all diabetes cases. From 131 countries around 221 data sources were selected to determine the diabetes prevalence per country. In today's era, diabetes has become one of the major global issues; it has not only killed and disabled people at their most productive age, but has also brought down the families to their knees and thereby decreasing the life expectancy.[2] One of the major late complications of type 2 diabetes mellitus is diabetic foot ulcer disease. One of the serious community health problems is Diabetic foot. Globally diabetic foot ulcer was 6.3% prevalent, which was more prevalent in males than in females and found greater in type 2 DM patients than in type 1 DM patients.[3] The two great pathologies of diabetic foot are Neuropathy and ischemia which lead to the characteristic features of foot ulceration and Charcot neuroarthropathy. Infection can make them complicated and can result in amputation which increases mortality.[4]. Evidences from epidemiological affirm that there's an affiliation between event of fringe blood vessel maladies and diabetes. Person with diabetes mellitus have a two to fourfold

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increment within the rate of fringe blood vessel disease. Diabetes mellitus increments the hazard of fringe blood vessel disease up to 2-4 folds by influencing endothelial and smooth muscle cell in fringe supply routes. The hazard of creating fringe blood vessel malady in lower limit is specifically corresponding to the term and seriousness of diabetes.[5] In 2016 AHA Coding for ICD-10-CM and ICD-10-PCS reported that Charcot's joints, foot ulcer, gangrene, autonomic (poly) neuropathy are among various late complications of diabetes related to peripheral vascular diseases.[6] Diabetic foot is chronic and severe lower limb complications. Around 40 to 60 million people with diabetes are affected globally. Due to Chronic ulcers and amputations quality of life is significantly reduced which also increase the risk of early death. According to international diabetes federation diabetes-related peripheral neuropathy is recognized by Less than one-third of physicians. Amputation is 10 to 20 times more common in people with diabetes and in every 30 seconds it is estimated that amputation related to diabetic neuropathy occurs[7]. To measure the flow of blood into peripheral vessels ankle brachial pressure index can prove to be an effective tool. Early detection, prompt treatment and measures taken to prevent the complication can be helpful for patients to avoid such complication and prevent limb amputation. Buerger Allen's exercise one of the physical therapies used to treat Buerger's disease which is a peripheral vascular disease. Buerger Allen's exercise proved to improve peripheral blood circulation and development of new collateral circulation. This can reduce mortality and morbidity related to diabetic foot ulcer disease and related limb amputation.

Hypothesis

H_1: There will be a significant difference between pre and post test of peripheral circulation due to Burger Allen's exercise among patients with Type 2 Diabetes Mellitus

Objectives

- To assess the peripheral circulation before Burger Allen's Exercise among patients with Type 2 Diabetes Mellitus.
- To assess the peripheral circulation after Burger Allen's Exercise among patients with Type 2 Diabetes Mellitus.
- To compare pre and post test score of peripheral circulation among patients with Type 2 Diabetes Mellitus.
- To determine the association of peripheral circulation before Burger Allen's Exercise among patients with Type 2 Diabetes Mellitus with their selected demographic and clinical variables.

Materials and Methods

Study population

Present study included 66 participants with type 2 Diabetes Mellitus were admitted in King George's medical university, Lucknow, utter Pradesh, India during the month of March 2021. Criteria for case inclusion were Patients who have given written consent, Suffering from Type 2 Diabetes Mellitus more than 5 years, Patients aged above 30 year, Patients present during the time of data collection, Patients who are admitted for 5 days or >5 days and are having mild to moderate blood glucose level control. Subjects were excluded from the study if they are Critically ill patients, Unconscious patients, Disoriented patients (unable to follow the command), Patient on anti-coagulant therapy or treatment of

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deep vein thrombosis, Patients suffering from diabetic foot ulcer, Patients with amputed lower extremities, Obese patient and Pregnant ladies.

Measures

Non- equivalent control group pre-post test design is used in present study. Two group were taken under the study experimental group (Buerger Allen Exercise) (n=33) and control group (no intervention) (n=33).

Assessment tool

Assessment of foot perfusion was done by ankle brachial pressure index scale and was done by digital sphygmomanometer. Blood pressure was measured from dorsalis pedis artery and brachial artery and the placed into the formula. Formula for Calculating Ankle Brachial Index Divide the higher of the dorsalis pedis systolic pressures for each ankle by the higher of the two upper extremity brachial systolic pressures to obtain the ankle brachial index for each of the lower extremities. Upon completing calculations, compare each reading with the interpretations below.

$$Ankle\ Brachial\ Index = \frac{Highest\ ankle\ pressure}{Highest\ brachial\ arm\ pressure}$$

Score interpretation Procedure 66 type 2 diabetes mellitus patients who had ankle brachial index scale score below 1 were selected for the study. In that 33 patients were selected for the experimental group and 33 patients were selected for the control group using purposive sampling. The objectives of the study were explained. Informed consent was obtained from both the groups .Demographic data was collected by using the self report questionnaire .Ankle brachial index scale was used to assess the foot perfusion by using digital sphygmomanometer.

Intervention

On day one Introduction of self to the patients and informed written consent was taken and instructions was given to the subjects regarding Buerger Allen's Exercise and pre test was conducted on same day using Ankle Brachial Pressure Index score measurement. From day 2 onwards intervention was given to subjects:

- Elevated feet on Padded chair or board for 3 minutes using a inverted chair until foot is completely blanched.
- Made the patient to sit in relaxed position while each foot is flexed and extended then pronated and supinated for 3 minutes. Feet should become entirely pink. If the feet are blue or painful, elevate them and relax as necessary.
- Made the patient to lie quietly for 5 minutes, keeping legs warm with a blanket.
- This intervention was given for 11 minutes, three times a day at four hours interval (9am, 01 pm, and 4pm) for a period of five days under the supervision and on day 6 Post assessments will be done by using the same scale.

Data Analysis

Data processing and analysis was done with MS Excel 2007. Data was summarized using standard procedures. Descriptive statistics are presented as frequencies, mean and standard deviation for normal and abnormal distributed parameters respectively. Paired t test and Chi square test was used. P values of less than 0.05 were assumed to be significant ($p < 0.05$).

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Results

Table I: distribution of demographic variables in experimental group and control group among Type 2 Diabetes Mellitus.

N=66

Demographic variables	Experimental group		Control group	
	N	%	N	%
Age (in years)				
30-40 years	4	12.12%	4	12.12%
40-50 years	13	39.39%	13	39.39%
50-60 years	7	21.21%	10	30.30%
60-70 years	9	27.27%	6	18.18%
Gender				
Male	28	84.85%	13	39.39%
Female	5	15.15%	20	60.61%
Others	0	0.00%	0	0.00%
Educational status				
Illiterate	4	12.12%	11	32.35%
Primary education	4	12.12%	5	14.71%
Secondary education	9	27.27%	5	14.71%
Graduation	10	30.30%	9	26.47%
Above graduation	6	18.18%	3	8.82%
Occupation				
Home maker	4	12.12%	19	55.88%
Unemployed	6	18.18%	2	5.88%
Unskilled laborer	6	18.18%	2	5.88%
Skilled laborer	6	18.18%	1	2.94%
Professional	11	33.33%	9	26.47%
Type of work				
Sedentary work	22	66.67%	21	61.76%
Moderate work	10	30.30%	12	35.29%
Heavy work	1	3.03%	0	0.00%
Diet pattern				
Vegetarian	13	39.39%	14	41.18%
Vegan	0	0.00%	0	0.00%
Occasionally non vegetarian	10	30.30%	15	44.12%
Non vegetarian	10	30.30%	4	11.76%
Personal habits				
Alcohol	8	22.86%	2	6.06%
Smoking	4	11.43%	2	6.06%
Tobacco	5	14.29%	1	3.03%

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All of the above	6	17.14%	5	14.29%
None of the above	10	28.57%	23	65.71%
Duration of Type 2 Diabetes Mellitus				
< 5 years	0	0.00%	0	0.00%
5-10 years	14	42.42%	13	38.24%
10-15 years	12	36.36%	15	44.12%
>15 years	7	21.21%	5	14.71%
History of associated illness				
ESRD	10	15.87%	8	24.24%
HTN	11	17.46%	10	15.63%
CAD	6	9.52%	7	10.94%
None of the above	6	9.52%	8	12.50%

Table I shows the demographic variables of the studied groups N=66. Most of the patients 39.39% were between the age group of 40-50 years in both control group and experimental group. Distribution of male and female in experimental and control group showed that majority of the patients (84.85%, 39.39%) were males in experimental group and control group respectively. Majority of participants (30.30%) were graduated in experimental group and illiterate (32.35%) in control group. Distribution of occupation showed that majority of participants was (33.33%) professionals in experimental group but home maker (55.88%) in control group. In both group most of the participants (66.67%, 61.76%) has sedentary type of work respectively. Maximum participants 39.39% showed interest in vegetarian diet in experimental group but 44.12% showed interest in occasionally non vegetarian diet in control group. Personal habits distribution showed that majority of participants consume alcohol in experimental group but majority of participants in control group have none of the ill habits. Distribution of duration of type 2 diabetes mellitus showed that maximum participants 42.42% have type 2 DM since 5-10 years but 44.12% participants showed duration of type 2 DM since 10-15 years in control group. Distribution of history of associated illness showed majority of participants (15.87%, 24.24%) has history of ESRD in both experimental group and control group respectively.

Table II: distribution of clinical variables in experimental group and control group among type 2 Diabetes Mellitus Patients.

N=66

Demographic variables	Experimental group		Control group	
	N	%	N	%
Latest HbA1c				
Below 5.7%	0	0.00%	0	0.00%
5.7% to 6.4%	27	81.82%	21	61.76%
More than 6.5%	6	18.18%	13	38.24%
BMI				

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Below 18	0	0.00%	0	0.00%
Between 19-24	12	36.36%	14	31.82%
Between 25-30	17	51.52%	11	25.00%
Above 30	4	12.12%	19	43.18%

Table II illustrate the distribution of clinical variables among type 2 Diabetes Mellitus Patients. Majority of participants has latest HbA1C (81.82%, 61.76%) between 5.7% to 6.4% in both groups. Distribution of BMI showed that majority of participants has BMI 51.52% Between 25-30 in experimental group and 43.18% participants has BMI above 30 in control group.

Table III: Comparison of ABI pre and post test mean scores on levels of foot perfusion among patients with Type 2 Diabetes Mellitus

N=66

Group	**Mean**		**SD**		**Mean difference**
	Pre test	**Post test**	**Pre test**	**Post test**	
Experimental group	0.785	0.927	0.178	0.158	0.141
Control group	0.918	0.884	0.248	0.289	0.033

Table III illustrate the Comparison of ABI pre and post test mean scores on levels of foot perfusion among patients with Type 2 Diabetes Mellitus. Pre test mean value and standard deviation is 0.785 and 0.178 of experimental group respectively and 0.918 and 0.248 of control group respectively. After practicing Buerger Allen's exercise the post test mean value and standard deviation is 0.927 and 0.158 of experimental group respectively and 0.884 and 0.289 of control group respectively.

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Table IV: Effectiveness of Buerger Allen's Exercise on of foot perfusion among patients with Type 2 Diabetes Mellitus

N=66

Post test	Mean	SD	Paired t test	P value
Experimental group	0.927	0.158	**2.2158**	**<0.05 significant**
Control group	0.884	0.289	**1.541**	**<0.05 not significant**

Table IV illustrate the post test mean scores on levels of foot perfusion among patients with Type 2 Diabetes Mellitus. The post test mean value and standard deviation is 0.927 and 0.158 of experimental group respectively and 0.884 and 0.289 of control group respectively. The t test value of experimental group is (2.2158) greater than that of the table value (1.6972) and less than table value in control group (1.541). This shows that Buerger Allen's Exercise is effective in improving foot perfusion among patients with Type 2 Diabetes Mellitus. Hence the research hypothesis (H_1) is accepted.

Table V: association of peripheral circulation before Burger Allen's Exercise among patients with Type 2 Diabetes Mellitus with their selected demographic and clinical variables

N=66

Association of peripheral circulation before Burger Allen's Exercise with their selected demographic variables								
Demographic variables	**Sample (n)**		**Foot Perfusion**				**'Chi' square x2 value**	**critical value**
	n	**%**	**>1**	**1-0.8**	**0.8-0.5**	**<0.5**		
Age (in years)								
30-40 years	8	12.12%	1	5	2	0	1.829, df= 9 NS*	16.92
40-50 years	26	39.39%	8	11	7	0		
50-60 years	17	25.75%	4	8	5	0		
60-70 years	15	22.72%	1	7	7	0		
Gender								
Male	41	62.12%	4	25	12	0	31.62, df= 6 S*	12.59
Female	25	37.87%	5	10	10	0		
others	0	0.00%	0	0	0	0		
Educational status							45.36, df= 12	21.03

Illiterate	15	22.73%	3	4	8	0	S*	
Primary education	9	13.63%	1	5	3	0		
Secondary education	14	22.73%	3	9	2	0		
Graduation	19	28.79%	2	11	6	0		
Above graduation	9	13.63%	2	5	2	0		
Occupation								
Home maker	23	36.36%	4	8	11	0		
Unemployed	8	12.12%	1	4	3	0	30.53, df= 12	21.03
Unskilled laborer	8	12.12%	1	6	1	0	S*	
Skilled laborer	7	10.61%	0	5	2	0		
Professional	20	30.30%	3	12	5	0		
Type of work								
Sedentary work	43	65.15%	7	20	16	0	14.94, df=6	12.59
Moderate work	22	34.84%	2	13	6	0	S*	
Heavy work	1	1.51%	0	1	0	0		
Diet pattern								
Vegetarian	27	40.91%	5	10	12	0		
Vegan	0	0.00%	0	0	0	0	22.73, df= 9	16.92
Occasionally non vegetarian	25	39.39%	3	16	6	0	S*	
Non vegetarian	14	21.21%	2	8	4	0		
Personal habits								
Alcohol	10	15.15%	2	5	3	0		
Smoking	6	9.09%	2	2	2	0	44.83, df= 12	21.02
Tobacco	6	9.09%	1	4	1	0	S*	
All of the above	11	16.66%	1	8	2	0		
None of the above	33	56.06%	11	10	12	0		
Duration of Type 2 Diabetes Mellitus								
< 5 years	0	0%	0	0	0	0	55.13, df= 9	16.92
5-10 years	27	40.90%	6	16	5	0	S*	
10-15 years	27	42.42%	4	13	10	0		
>15 years	12	18.18%	1	5	6	0		
History of associated illness							50.13, df= 9 S*	16.92

ESRD	18	40.90%	3	10	5	0		
HTN	21	65.15%	5	9	7	0		
CAD	13	24.24%	1	7	5	0		
None of the above	14	21.21%	7	4	3	0		
Association of peripheral circulation before Burger Allen's Exercise with their selected clinical variables								
Latest HbA1c								
Below 5.7%	0	0%	0	0	0	0	81.60, df= 3	7.81
5.7% to 6.4%	48	72.72%	5	24	19	0	S*	
More than 6.5%	19	28.78%	4	11	4	0		
BMI								
Below 18	0	0%	0	0	0	0	57.07, df= 9 S*	16.92
Between 19-24	24	39.39%	3	10	11	0		
Between 25-30	29	42.42%	1	19	9	0		
Above 30	13	34.48%	4	5	1	0		

Table V illustrate the statistical outcome of 'Chi' square analysis. It was used to find out the association between pre tests score of foot perfusion and selected demographic and clinical variables. The table shows that there is a significant variation between the demographic variables such as gender, education, occupation, diet pattern, personal habits, duration of diabetes mellitus but no significant variation between demographic variable age and peripheral circulation.

Discussions

Analysis of the 1st objective of the study i.e. to assess the peripheral circulation before Burger Allen's Exercise among patients with Type 2 Diabetes Mellitus.

The data identified from the present study shows that the pre test means scores of ABI is 0.79 for experimental group and 0.91 in control group where it shows that level of foot perfusion is low in patients with Type 2 Diabetes Mellitus patients.

- These findings are compatible to a study done by Ms. Manjula j (2020) and infer that the maximum number of Type 2 Diabetes Mellitus patients 76.7% was having lower ABI score showed higher risk of developing peripheral vascular disease.[8]
- The findings are also compatible with the study performed by Parimala. L, Vishnu Priya. U and infer the that majority of Type 2 Diabetes Mellitus patients 84% were having lower ABI score showed high risk of developing peripheral vascular disease.[9]

Analysis of 2nd objective i.e. to assess the peripheral circulation after Burger Allen's Exercise among patients with Type 2 Diabetes Mellitus.

The data identified from the present study shows that the post test means scores of ABI is 0.93 for experimental group and 0.88 in control group where it shows that foot perfusion is low in patients

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with Type 2 Diabetes Mellitus patients.

- These findings are congruous with the study conducted by Ms. Towar Shilshi Lamkang, Dr. Aruna, S. and Dr. Mangala Gowri, P. in 2017 on 60 Type 2 Diabetes Mellitus patients. The results of the study infer that pre test mean score was 0.68 in both experimental group and control group but post test mean score in experimental group was 0.84 whereas 0.68 in control group. This shows the effectiveness of Buerger Allen's Exercise.[10]
- These findings are also consistent with the study conducted by Jemcy John and A.Rathiga among 60 Type 2 Diabetes Mellitus patients. The findings of the study showed that pre test score in experimental group was 0.9220 and 0.8427 in control group whereas post test mean score 0.9800 in experimental group and 0.8400 in control group. This shows the effectiveness of Buerger Allen's Exercise.[11]

Analysis of 3rd objective i.e. to compare pre and post test score of peripheral circulation among patients with Type 2 Diabetes Mellitus.

The data identified from the present study shows that pre test mean score and standard deviation of experimental group is 0.79 and 0.18 respectively and post test mean score and standard deviation is 0.93 and 0.14 respectively. Mean difference found to be 0.14 in experimental group and 0.03 in control group. Paired 't' test was (2.2158) greater than table value 2.037 of experimental group prove that this is statistically significant at $p < 0.05$.

- These findings are consistent to the study conducted by Leelavathi. M (2015) among 30 Type 2 Diabetes Mellitus patients. The study revealed that pre test mean score and standard deviation in experimental group found to be 21 and 2.41 respectively and post test mean score and standard deviation is 7.83 and 2. 913 respectively. Paired 't' test was 16.24 which is statistically significant at $p<0.001$.[12]
- These findings are also consistent to the study conducted by Bincy Baby (2015) among 30 Type 2 Diabetes Mellitus patients. The study revealed that pre test mean score and standard deviation found to be 4.87 and 1.14 respectively and post test mean score and standard deviation is 0.83 and 0.87 respectively. Paired 't' test was 17.74 which is statistically significant at $p<0.001$.[13]

Analysis of 4th objective i.e. to determine the association of peripheral circulation before Burger Allen's Exercise among patients with Type 2 Diabetes Mellitus with their selected demographic and clinical variables.

The data identified from the present study shows that All 'Chi' Square value is statistically significant at $p< 0.05$ level except diet which depicts that all the demographic variable and clinical variables are associated with ABI scores**.**

- These finding is consistent to the study conducted by Bhuvaneshwari S, Tamilselvi S among 30 Type 2 Diabetes Mellitus patients. The study revealed that association between the demographic variables and foot perfusion patients with Type 2 Diabetes Mellitus in the post-test experimental group.[14]
- These findings are inconsistent to the study conducted by Mrs. Priya. N among 40 Type 2 Diabetes Mellitus patients. The study revealed that only age and BMI are having association and others does not have any association i.e. diet, occupation, type of work, education e.t.c.[15]

Conclusion

Amputation in people with diabetes is **10 to 20 times more common** than in people without diabetes

and it is estimated that **every 30 seconds** a lower limb or part of a lower limb is lost somewhere in the world as a consequence of diabetes. This has to be taken into consideration. The findings of the present study revealed that here is a significant improvement in the lower extremity perfusion after doing Buerger Allen exercise .Buerger Allen exercise was found to be effective on improving the lower extremity perfusion among patients with diabetes mellitus. However studies with larger sample size and longer duration of intervention suggest.

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